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Reprinted from TRANSACTIONS OF THE AMERICAN FISHERIES SOCIETY
Vol. 94, No. 3, July 1965
pp. 277–278

Effects of Injected Biological Stains on Oxygen Uptake by Shrimp[1]

Rates of growth and mortality in populations of fish and shellfish may be estimated by means of mark–recapture experiments. Unfortunately, some tags or marks adversely affect the behavior, physiology, and survival of the animals involved (Clancy, 1963; Barrett and Connor, 1962). Accordingly, their careless use can result in biased estimates of growth and mortality parameters.

Estimates of these parameters for populations of several penaeid shrimps have been obtained from experiments in which biological stains were used as the marking agent (Klima, 1964; Kutkuhn, in press). The effects of such stains on the physiology and growth of shrimp had not, however, been previously investigated. Since the injected dye concentrates in the gills of the animal, the question has arisen as to whether or not it impedes oxygen uptake through physical clogging or by chemical injury to the gill tissue. It is hypothesized that any inhibition of respiratory activity could reduce the shrimp's metabolic rate and thereby retard its growth. The following experiments were designed to measure the influence of biological stains, if any, on oxygen uptake by shrimp.

Prior to experimentation, brown shrimp, *Penaeus aztecus*, ranging in total length from 83 to 110 mm, were conditioned to a recirculating seawater medium for several days. Half the shrimp were then injected with a 0.5% solution of fast green (FCF) stain following the method described by Costello (1964), and half were established as a control group (Tables 1 and 2). The oxygen consumed by whole shrimp, as well as by gill tissue excised from stain-marked and unmarked shrimp, was measured daily for 5 days following the start of the experiment. Final measurements were made on the 11th day. Determinations of oxygen uptake by the whole animal were made using the Winkler technique described by Strickland and Parson (1963, p. 23–28). The oxygen consumed by individual gill filaments was measured in Warburg respirometers.

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TABLE 1.—*Oxygen uptake by whole brown shrimp, expressed as ml O_2/g per hr (wet weight)*

Tested group	Number of experimental animals	Average oxygen consumed	Standard deviation
Stained	12	0.29	0.08
Unstained	12	0.31	0.07

Shrimp in both the treated and control groups were exercised for 10 minutes before experimentation to stimulate their respiration. They were then isolated in plastic containers of about 5 liters' capacity. A sample of the medium in each container was then withdrawn to determine its initial oxygen content. Thereafter, each shrimp was allowed to respire in the closed container for 1 hour. The oxygen taken up by individual animals was calculated as the difference in oxygen content of the water at the beginning and end of the experimental period.

Gill tissue was removed from shrimp used in the whole-animal experiments as well as from four other specimens selected at random for each test. Such material, kept separate for each animal, was placed in 15-ml Warburg respirometer flasks containing 3.0 ml of filtered seawater. Carbon dioxide was absorbed with 0.2 ml of a 10% KOH solution. Oxygen uptake was measured for a period of 1 hour, since it was determined that respiration was maintained at a constant rate under these conditions (Figure 1).

Analyses of the experimental results were simplified because the amount of oxygen consumed by whole animals and by the isolated gill tissue did not change significantly from day to day. Nor was there any significant trend in oxygen uptake with time.

The average quantities of oxygen taken up by whole shrimp and excised gill tissue are given in Tables 1 and 2. These statistics indicate no difference in the amount of oxygen consumed by stained and unstained shrimp. We therefore conclude that the presence of

TABLE 2.—*Oxygen uptake by gill tissue excised from brown shrimp, expressed as μl O_2/mg per hr (dry weight)*

Tested group	Number of experimental animals	Average oxygen consumed	Standard deviation
Stained	24	4.67	1.04
Unstained	24	4.70	1.01

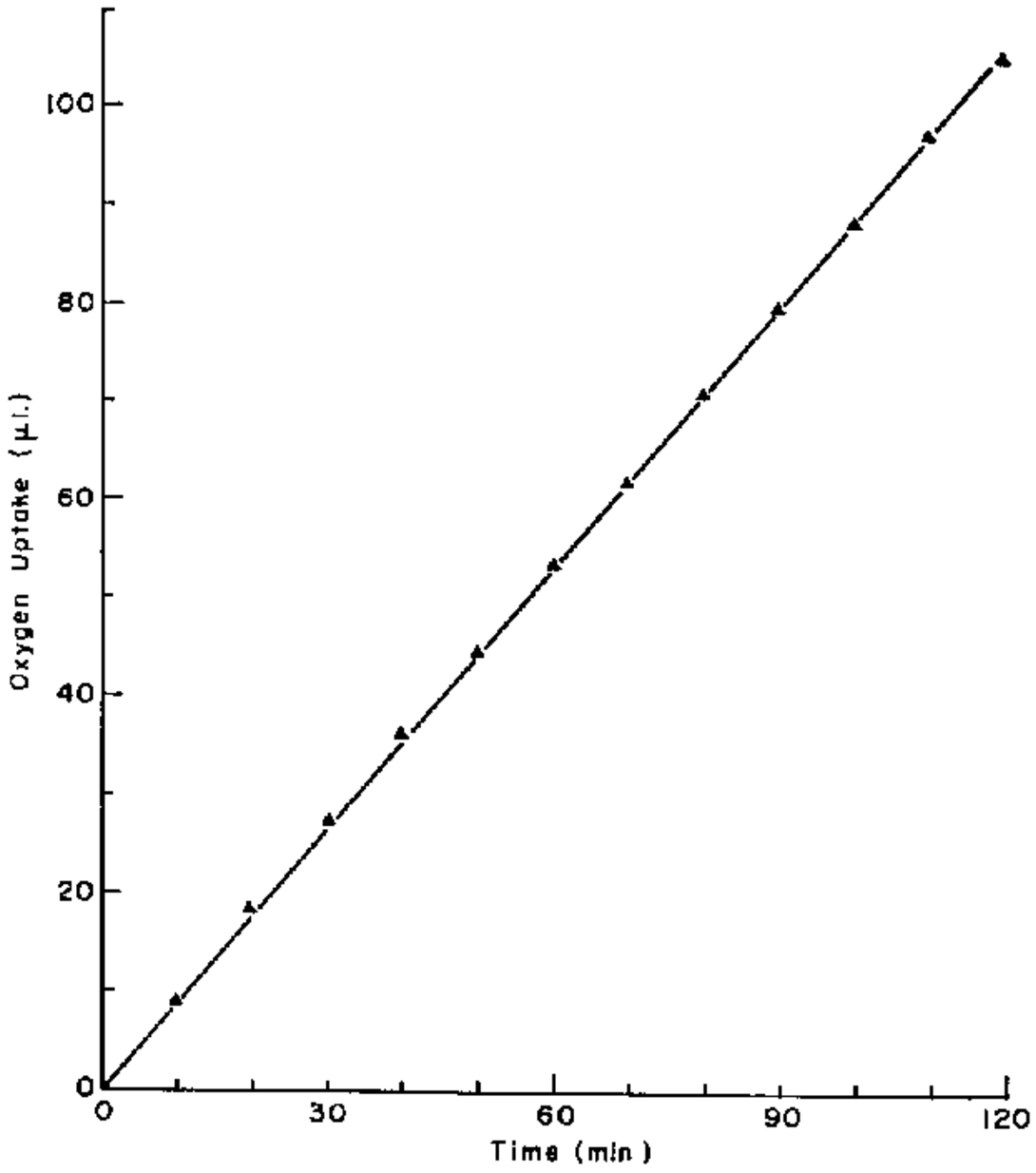

FIGURE 1.—Oxygen uptake of gill tissue from subadult brown shrimp as a function of time.

fast green (FCF) does not grossly effect the metabolic rate of brown shrimp. This finding increases our confidence in the reliability of growth-parameter estimates derived from the results of shrimp mark–recapture experiments in which this dye is used.

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